COMMONWEALTH OF AUSTRALIA

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CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 2, 2015

FINAL EXAMINATION	**DURATION**
SBI209 – Design and Analysis of Biological Studies	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

Answers should be written in the booklet provided.

Please ensure that your Name and Student Number are written clearly in the space provided at the top of the booklet.

Note that questions ARE of equal value.

Read ALL questions carefully.

Do not commence writing until instructed to do so.

Writing on scrap paper during Reading Time is permitted.

EXAM CONDITIONS

This is a RESTRICTED OPEN BOOK examination.

Any calculator is permitted.

No handwritten notes are permitted.

Hard copy, unannotated English translation dictionary only.

Answer on the supplied examination material/s only.

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted.	1 x 8 Page Book 1 x 20 Page Book Formula Sheet/s Statistical Table/s

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Twelve (12) short-answer questions

Total number of marks for this section: 180

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Marks for each question are indicated.

Suggested time allocation for this section: 180 minutes.

Note: Numbers in square brackets (e.g. [2]) indicate data sources (listed at the end of the paper).

Question 1

Describe what "confounded" means when referring to the design of an experiment and give two examples.

(15 minutes = 15 marks)

Question 2

According to Glover & Mitchell (2002), the northern leopard frog (*Rana pipens*) has a sex ratio in most populations of 60% females to 40% males [1]. If a random sample of 20 frogs is taken from a pond, calculate the probability of the following outcomes:

(i) No (0) male frogs (out of 20).

(ii) Eight (8) male frogs (out of 20).

(iii) Sixteen (16) male frogs (out of 20).

(15 minutes = 15 marks)

Question 3

A common way to test for contamination of water is by testing for the presence of various bacteria such as *E. coli* [2]. NRMMC (2011) state that "*Escherichia coli* (*E. coli*) should not be detected in a minimum 100mL sample of drinking water." This is similar to testing the following null hypothesis: "The number of E. coli in the water sample equals zero (0)." Briefly describe the potential consequences of the following two situations:

(i) A Type I error is made.

(ii) A Type II error is made.

(15 minutes = 15 marks)

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Question 4

Describe three different types of sampling strategies (or schemes) that include a random sampling component and give one advantage and one disadvantage for each strategy.

(15 minutes = 15 marks)

Question 5

The level of sodium in healthy individuals has a mean equal to 141.5 meq/l (mmol/l) and a standard deviation of 3.25 [Baptist Medical Centre, cited in 3]. If values in the range 135 to 145 are considered normal, and less than 120 is considered critical [4], calculate the proportion of the population which would have the following values:

(i) Less than 135.

(ii) Greater than 145.

(iii) Less than 120.

(15 minutes = 15 marks)

Question 6

In a study of hermit crab behaviour on the Great Barrier Reef [1], the shells of three species of marine snail were collected and then scored as "empty" or "occupied by a hermit crab." Shells occupied by a living snail were not counted. The aim was to see if hermit crabs preferred particular kinds of shells. Test the hypothesis below using the data in the table:

H_0: The proportion of shells occupied does not differ among snail species.

Table 1: Counts of occupied and empty snail shells.

Snail species→	***Astrocochlea***	***Bembicium***	***Cirithid***
Occupied	47	10	125
Empty	42	41	49

(15 minutes = 15 marks)

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Question 7

The northern Japanese have recorded how many severe cyclones hit the islands every year [1]. The table below shows that, for example, 149 years had no (0) cyclones, 24 years had one (1) cyclone arrive and 15 years had two (2). Test the following null hypothesis:

H_0: Cyclones occur randomly among years.

Table 2: Counts of number of cyclones each year.

Cyclones→	**0**	**1**	**2**	**3**	**4**	**5**
Count→	149	24	15	5	4	3

(15 minutes = 15 marks)

Question 8

Loader et al. (2012) studied drills, training and game-play in AFL players and grouped activities into three clusters: “game-specific conditioning”; “skill refining/moderate intensity dominant”; and “skill refining/low intensity dominant”. They then looked at metres per minute (m/min) travelled in a range of different activities, such as walking, jogging and sprinting. Complete the analysis below, and do any other procedures required, to test the following null hypothesis:

H_0: Mean m/min sprinting is the same for all clusters.

Table 3: Mean m/minute sprinting in each cluster.

Cluster→	**1**	**2**	**3**
m/min→	153.1	310.6	326.9

Table 4: Partially completed analysis of data.

Source	**SS**	**df**
Among	184209	2
Within	6014	27
Total	190223	29

(15 minutes = 15 marks)

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Question 9

If impurities are added to pure water, the boiling point increases so one way of testing for impurities is by measuring the boiling point. Five (5) water samples are taken from two tanks holding drinking water. For each tank, test the following null hypothesis:

H_0: The mean boiling point is equal to 100.0.

Table 5: Boiling point of water samples from two tanks.

Tank 1→	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Boiling point→	101.2	100.7	102.9	101.2	102.2
Tank 2→	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Boiling point →	99.9	99.7	101.2	100.3	100.7

(15 minutes = 15 marks)

Question 10

A study measured the systolic blood pressure of smokers and non-smokers, with moderate and high sodium intake [1]. There were six subjects in each group: 24 subjects in total. State appropriate null hypotheses, complete the analysis, draw conclusions about these hypotheses, and about the effects of sodium intake and smoking.

Table 8: Systolic blood pressure of subjects.

	Moderate sodium	**High sodium**
Non-smokers	128.8	143.2
Smokers	135.3	157.27

Table 8: Partially completed analysis of data.

Source	**SS**	**df**	**MS**	**F**
A: Sodium	2053.5	1	2053.5	17.38
B: Smoking	682.7	1		
A×B	66.7	1		
Within/Error	2363.0	20		
Total	5165.8	23		

(15 minutes = 15 marks)

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Question 11

Male dragonflies defend territories which are visited by females when they lay eggs. Researchers used forewing length as a measure of male size and ranked the territories defended by each male in terms of quality (1 = highest quality or best; 9 = lowest) [1]. Using the data in the data table, test the null hypothesis below:

H_0: Territory rank and forewing length are not correlated.

Table 6: Territory rank and forewing length of dragonflies.

Dragonfly→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Rank→	1	2	3	4	5	6	7	8	9
Length→	15.1	14.9	14.7	15.3	14.1	14.5	14.3	15.0	13.8

(15 minutes = 15 marks)

Question 12

Six (6) pairs of subjects are used to test the effectiveness of two speed reading programs [7]. Subjects are matched on the basis of initial reading speed (i.e. speed before doing either program). The subjects complete the speed reading program and their speed is retested. Using the data in the table, test the following null hypothesis:

H_0: Mean speed after Program 1 equals mean speed after Program 2.

Table 7: Reading speeds for subjects after completing one of two speed reading courses.

	Pair					
	1	**2**	**3**	**4**	**5**	**6**
Program 1	1114	979	910	1091	996	1032
Program 2	996	1125	1056	1053	894	1148

(15 minutes = 15 marks)

Data sources

1. Glover, T & Mitchell, K 2002 *An Introduction to Biostatistics*. McGraw-Hill, Boston.
2. NRMMC 2011 Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
3. Milton, JS 1992 *Statistical Methods in the Biological and Health sciences*. McGraw-Hill Inc, New York.
4. Loader, J et al. 2012 Classyfing training drills based on movement demands in Australian Football. *International Journal of Sports Science & Coaching* 7:57-67.
5. Howantiz, JH, Howantiz, PJ 2007 Evaluation of serum and blood sodium critical levels. *American Journal of Clinical* Pathology 127:56-59. http://www.medscape.com/viewarticle/549890_4. Accessed: 24/08/15.
6. Selvin, S 2004 *Biostatistics: How it Works*. Pearson Education Inc, New Jersey.
7. Weiss, NA 1982 *Introductory Statistics*. Addison-Wesley Publishing Company Inc, New York.

Any data with no source listed is from Keith McGuinness.

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FORMULAS and DATA SOURCES

Note – you may **NOT** need to use all of these.

1. $$\Pr(r) = \frac{n!}{r!(n-r)!} \times p^r (1-p)^{n-r}$$

2. $$\Pr(r) = \frac{e^{-\mu}\mu^r}{r!}$$

3. $$t = \frac{\overline{X}_1 - \overline{X}_2}{SE}$$

where

$$SE = \sqrt{\frac{s_c^2(n_1+n_2)}{n_1 \times n_2}}$$

$$s_c^2 = \frac{s_1^2(n_1-1)+s_2^2(n_2-1)}{(n_1+n_2-2)}$$

4. $$r = \frac{C_{xy}}{\sqrt{SS_x \times SS_y}}$$

where

$$C_{xy} = \sum XY - \frac{\sum X \sum Y}{n}$$

$$SS_x = \sum X^2 - \frac{\left(\sum X\right)^2}{n}$$

$$SS_y = \sum Y^2 - \frac{\left(\sum Y\right)^2}{n}$$

5. $$r_s = 1 - \frac{6\sum d^2}{(n^3-n)}$$

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